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*EXTRACTS FROM A REPORT PRESENTED
TO THE CORPORATION OF THE MASSA-
CHUSETTS INSTITUTE OF TECHNOLOGY
BY ARTHUR A. NOYES,
ACTING-PRESIDENT*

FACULTY ORGANIZATION

THE faculty has during the past year perfected its organization and has made provision for carrying on more effectively its administrative functions by the creation of the office of chairman and by the appointment of new committees on faculty business, on faculty rules, and on the courses of instruction. Our faculty, like that of many other educational institutions, has now become so large that it can not properly deal with the details of administration; but instead of establishing a single administrative board consisting of a small number of its representatives, it has gradually developed the more democratic, and, we believe, the more effective, plan of placing its numerous and varied functions under the charge of about twenty-five standing committees, which are empowered to take final action upon all special and individual cases that arise, and are expected to take the initiative in submitting to the faculty for its approval any important changes of policy or procedure that seem desirable. I would especially call your attention to the resolution in which the faculty "expresses its appreciation of the desirability of some form of advisory relation between the corporation and the faculty, and its readiness to cooperate with the corporation in the preparation of a plan for establishing such a relation."

DEVELOPMENTS IN THE WORK OF
INSTRUCTION

The curricula of all the strictly engineering courses have been modified during the past two years by the omission, wholly or in part, of the second-year work in modern languages; and the time gained has

been utilized to increase the amount of instruction in English and history, and to give a more thorough drill in fundamental engineering subjects, especially in applied mechanics, structures and steam engineering. It is felt that few engineers make practical use of their knowledge of modern languages, and that the general and scientific studies that have been substituted are not only more directly useful, but either have a higher cultural value or provide a better mental training.

Important progress in the development of our advanced work has been made by greatly extending and systematizing the subjects of instruction offered to candidates in fifth-year courses leading to the degree of master of science. Almost every department has announced, and is prepared to offer in the next school-year, advanced courses of a somewhat more specialized character than can be given to undergraduate students. Thus in civil engineering, further work in the design of structures (particularly those of reenforced concrete), of railroads and of hydraulic works, is offered; in mechanical engineering, further study of turbine and gas engines and of machine design is provided for; in architecture, advanced courses in the various branches of architectural design are announced; and similarly in all other departments advanced work has been arranged for. The broad significance of this form of development and its bearing on the character of our undergraduate courses I shall speak of later.

A special inducement to pursue such advanced work has been offered to graduates from other colleges by a recent vote of the faculty, which permits them to enter at once upon a course leading to the degree of master of science without previously taking our bachelor's degree. This course will, in general, extend over a period of two or three years, varying according to

the previous preparation of the college student.

There are, however, no developments of any kind which are so important as those which tend to increase the effectiveness of our undergraduate instruction in meeting the needs of the individual student. I am glad to be able to tell you that this year an important step in this direction has been taken by the initiation of a plan of individual conferences between the instructor and students in certain first-year subjects. Owing to the inadequacy of the funds available for the purpose—for it involves additional instructors of first-rate ability—it has been possible this year to put this plan in force only to a limited extent in the subjects of English and mathematics. It is, we believe, of great importance that this plan be largely extended as rapidly as our facilities admit; for it is undoubtedly true that many of the students who now fail to reach our standards could overcome their difficulties if they could receive more help in learning how to study and more personal encouragement and stimulation. The conference plan also develops an attitude of cordiality and mutual helpfulness both in the instructing staff and the student body which is the essence of a healthy college spirit.

The instruction in the department of mathematics is undergoing a somewhat radical revision, in which the old divisions into advanced algebra, analytic geometry, differential and integral calculus are in large measure obliterated, and the whole subject is presented, irrespective of this traditional grouping, in a manner most economical and advantageous for the student, and with the help of a large number of concrete applications.

THE EDUCATIONAL FIELD OF THE INSTITUTE

It is well, I believe, for the corporation to take under consideration from time to

time those fundamental principles which express the main purposes for which the institute exists and which should determine the educational field which it is to occupy and the directions in which it is to be developed. In this belief, I present my views for your consideration.

Its Function as an Undergraduate School

First of all, I believe that it should be clearly recognized that one of its main functions, as an independent scientific school, is to educate for the scientific and engineering professions young men who have previously received only a high-school education. It must remain in large measure a school for undergraduates, and must not allow itself through the influence of the policies of universities to become only a graduate school for the professional training of the former students of other colleges. The question here at issue is not which is more advantageous—a professional training preceded by a liberal education of an elective character or a coordination of the two in a single prescribed course—but whether or not there is a large field for education of the latter type. Some may prefer to drive tandem, with a loose rein upon the leader, and some to drive abreast; but none wishes his freedom of choice restricted. By the establishment in this community of the Graduate School of Applied Science at Harvard University, and by a similar development at other universities throughout the country, ample provision will doubtless be made, as fast as the demand arises, for the engineering education of college graduates. It should be, on the other hand, the especial care of the institute to maintain and develop that combination of liberal and professional training for undergraduate students, for which it has stood from its foundation. If ever the demand for this type of education should cease, or if ever it be demon-

strated that this type when properly developed produces only engineers and scientists of an inferior grade, then, and not till then, will it be time to consider the conversion of the institute into a purely graduate school. To abandon at this stage the educational experiment which the institute is making, instead of coping with the difficulties in its problem which have become apparent, would be a betrayal of the trust which its past imposes and a severe blow to the educational development of this country. There is as yet no indication that the sources that have directly fed the streams which are inundating our technological schools are drying up, nor is there as yet any adequate experience which warrants us in diverting those streams into a different channel. It is certainly desirable that there be developed the new type of engineering education, in which cultural subjects are given as collegiate courses and the professional training in a graduate school; but this is not *our* field of educational service. Such a development is to be welcomed, in part because it is a stimulus to us to study the conditions for making our own type of education more effective. We must therefore not allow our attack upon the problems of undergraduate education to be weakened by theories as to the tendencies of professional education under university conditions, nor by inconclusive comparisons between the results attained in graduate schools of law and medicine and those that may be expected in similar schools of applied science.

The second principle which I desire to emphasize is that already indicated by my preceding words, namely, that, as an independent undergraduate school, the educational problem of the institute is necessarily of a twofold character: we have to develop a plan of education which is adapted to produce not only well-trained engineers, but also broad-minded, high-

purposed men. We must aim to make the work of the students at the institute and the conditions of their life outside such as lead to a duly proportioned development in these two directions.

It is sometimes said, however, that in attempting to solve this twofold problem in a four-year undergraduate course, the institute is undertaking a hopeless task. This contention I would meet by the statement, that, whether or not it be hopeless to give a fully adequate education upon these two sides within the period of four years, it is our present problem to do this in as large a measure as is possible; for to further increase this minimum period of study would close the doors of the institutions of technological education to a large number of young men whose financial resources are already taxed to the utmost. Moreover, the careers of institute graduates warrant the conclusion that the results attained in the past are as a whole satisfactory; and when the many possibilities of further development in our educational work and the conditions of student life are considered, the future outlook for a fuller success of the four-year course is a bright one. Before conceding the necessity of an extension of this period of study, we must at least consider the possibility of utilizing in part the intermediate summer vacations, which now cover no less than one third of the whole year: but to this matter I shall return later.

Specialization in a Fifth Year

The general principle which should determine the character of our four-year course of study—a principle fully recognized by our faculty—is that a liberal education be provided such as will develop character, breadth of view, and high ideals of service, and that professional education be mainly confined to a thorough training in the principles of the fundamental sci-

ences and in scientific method, specific engineering subjects being included only so far as the remaining time permits and as the minimum requirements of professional practise demand. It should be our aim not to turn out a specialist at the end of a four-year curriculum, but rather to provide for specialization in a fifth-year graduate course. By courageously eliminating from our fourth-year curriculum the more technical branches of instruction, however important they may be for the practising engineer, and by making more ample provision for them as subjects to be pursued in graduate courses, we shall, on the one hand, be enabled to make our undergraduate course more educational in the broadest sense, and, on the other hand, to make more evident to the student the practical importance of returning for a fifth year to acquire the more specialized knowledge of the separate engineering professions. This, then, is the direction in which, in my judgment, the courses of study at the institute should be developed: we will give in our four-year undergraduate course an even broader and deeper training than at present in cultural and fundamental scientific studies—a training which will still enable those students that are obliged to do so to enter at once upon the practise of their professions, handicapped somewhat, it may be, by the lack of technical experience, but with a sound knowledge of principles and a developed mental power which will gradually enable them to overcome this disadvantage; and, on the other hand, we will develop graduate courses of such a character as will obviously remedy this deficiency of insufficient specialization and will attract such graduates of this institution and of other scientific schools as are financially able to continue their education. We shall thus create a type of graduate school in which is offered advanced training for

bachelors of science rather than for bachelors of arts.

Opportunities for College Graduates

But these are by no means the only fields which the institute should occupy. Some of the other directions in which our development must be continued or extended also deserve consideration.

We must, while not permitting any sacrifice of the instruction of our undergraduate students, encourage the graduates of colleges to enter the higher years of our regular courses and our advanced courses, and offer them such additional facilities as their different preparation demands. Future experience alone can determine whether such graduates will receive a better education in the graduate schools of universities in courses attended, often not only by themselves, but by college men without definite professional aim, or in scientific schools working side by side in the undergraduate courses with men earnestly devoted to preparation for their profession. The presence together of these two groups of men is certainly mutually advantageous: the graduate student from another institution tends to broaden the interests of his undergraduate associate; and the latter imbues the former with that spirit of hard work and seriousness of purpose which attendance at the scientific school has inspired. For these reasons we must not fail to provide suitable courses and conditions of work for the college graduates who are coming to us in constantly increasing numbers.

Five-year Courses for the Bachelors Degree

Far more important, however, than the offering of increased opportunities for college students, is a more ample provision within this institution itself for the education of such students coming directly from the preparatory schools as are able to

devote more than four years to general and fundamental studies. In emphasizing the importance of maintaining our undergraduate four-year course I should be sorry to give the impression that that period is considered a fully adequate one. On the contrary, I believe the institute should at once meet the demand for a broader education of its students by a development of a three-year course in general science, which shall contain, partly as required work, and partly as electives, all or nearly all those subjects of instruction now included in the first two years of the various courses of the institute, so that the latter may be completed in two years more by students who have finished the three-year science course. This plan would enable three years instead of two to be devoted to the humanistic branches of study, to the nature sciences, and to the fundamental physical sciences. It would in large measure provide the breadth of scholarship which the college course is designed to supply, and would do this by the methods and in the atmosphere of the scientific school. Owing to the facts that a long list of electives in general studies is already offered to our third-year students, and that many of the scientific subjects that would naturally be included are already given by one or other of our science departments, this course in general science could be arranged for at comparatively small additional expense. It would be desirable, however, that one new professor be appointed, who might offer courses in philosophy, psychology and logic.

ADVANCED STUDY AND RESEARCH

Development is also of the greatest importance in the direction of larger opportunities and inducements for research work and advanced studies in the pure and applied sciences which form the basis of our curriculum. An institution of learning

which does not contribute through the researches of its instructing staff and graduate students to the advancement of science can not secure the highest grade of teachers, can not keep its courses of instruction upon the plane of broad and deep scholarship, and can not retain its educational prestige. I have already spoken of one kind of advanced course which we are already developing—one which would provide the more specialized instruction in engineering subjects which industrial advances are making more and more imperative. Such a course, which hardly needs to be of more than one year's duration, leads to the degree of master of science. There is, however, a second kind of advanced course which is even more essential to the development of the highest type of scientist or engineer. This is a course in which the student, while pursuing more advanced studies in the underlying sciences, devotes himself mainly to the original investigation of problems in pure or applied science. It is investigation work of this sort which tends to develop the creative power of the man and his ability to handle new problems relating to the improvement of industrial processes and engineering methods. Such a course, when of two or three years' duration, may lead to the degree of doctor of philosophy or doctor of engineering. The institute has already made encouraging progress in this direction; but the number of students engaged in such work has thus far been small.

REDUCED TUITION AND ADDITIONAL SCHOLARSHIP AID

Next in importance to this matter of making provision for our immediate needs and future development comes the question of reduced tuition fees or increased scholarship aid. The high cost of the kind of instruction furnished by the institute made it seem necessary a few years ago

to increase our tuition fee to \$250. This increase will, I earnestly hope, be regarded as only a temporary expedient for which a remedy must be found at the earliest moment. The present high tuition not only is shutting out a large group of promising young men from the advantages of a scientific and engineering education, but is imposing upon another large group a financial burden which they are scarcely able to bear, and which forces them to live and to work under conditions unfavorable to their health and social development. Any of the administrative officers of the institute could recount numerous instances where men have been obliged to withdraw from the institute because they could not raise the last fifty dollars of their tuition, or where they have been living on thirty or forty cents a day in order to meet it. Our high tuition is, moreover, sending young men more and more to the other less expensive collegiate institutions. Many of these take the full courses of study there, but there is a large and increasing number who for reasons of economy replace the first year or first two years of the institute course by corresponding work at another institution, and then enter the second or the third year of the institute. There is involved in this plan a lack of continuity and of adequate preparation which is unfortunate.

While we are not interested in bringing about any large increase in the number of our students, we are concerned in drawing to us young men of the highest quality. We must, therefore, not permit the financial resources of applicants to be the principle of elimination in any greater measure than is absolutely essential. There is, in my opinion, no form of educational expenditure which produces so large a return to the community as the higher training for the scientific and engineering professions of those comparatively few young

men whose character and ability are such as to enable them to rise to positions of leadership. And this type is, I believe, most commonly developed among families which have sufficient means to send their sons to the high school, but yet have trained them to work in the summers and at other odd times to earn money towards their own support. Boys from poorer families are unfortunately not likely to have the opportunity of even a high-school education or the home surroundings or antecedents which conduce to intellectual development, while those from richer families are apt to lack the earnestness of purpose and inclination to subordinate the pursuit of pleasures to thorough preparation for a life of service which is acquired by the boy who has already learned to work. It is, however, just such families of small means which are finding it exceedingly difficult, if not impossible, to meet the high expense of technological education.

This difficulty may be met in either of two ways—by a general reduction of our tuition fee or by providing larger funds for scholarship aid to individual students. Under the existing conditions a combination of the two methods seems most advisable. To reduce our tuition fee for all our students would involve such a large reduction of our income that it probably can not be immediately considered; but it might be practicable to adopt the plan of reducing the tuition fee for first-year students. The advantages of this reduction in tuition for first-year students are proportionally far greater than a corresponding reduction for those of the higher years—desirable as the latter is. It would enable a larger number of properly prepared students to enter the institute; and the most deserving of these, after they had demonstrated their ability by their first year's work, could be assisted to continue

by grants from our scholarship funds and those of the state, which can not be awarded with proper discrimination to boys in advance of their coming to the institute. Moreover, as the student gets older and has had more training, it is easier for him to get remunerative employment in the summer vacations. It will, too, diminish the tendency for students to go to other institutions for a single year or two merely for reasons of economy. Finally it is the most equitable and from a financial standpoint the safest one for the institute to pursue in effecting a reduction of its tuition charges, since the first-year instruction is less costly than the more specialized instruction of the higher years. This plan would, however, remedy only in part the difficulties of our high tuition; for our scholarship funds are not adequate to meet the needs of our deserving students in the higher years. This is fairly evident merely from the statement that the scholarship grants to undergraduate students formed last year only nine per cent. of the total tuition fees paid by them. Ampler funds must, therefore, be secured either through an appeal to the generosity of private donors or through further grants from this commonwealth, which can not afford to allow the opportunity of a higher technological education to remain closed to such of its youth as are fully qualified to receive it.

REQUIRED SUMMER WORK

Coming now to matters more closely related to the work of instruction, I would first bring to your attention the extension of the required work of the institute courses for a period of four or five weeks into the summer. Such an extension can best be made, not by lengthening our present term, but by providing summer schools which our regular students are required to attend and to which they will be admitted free of charge, in the summers at the end

of the first two school years. The importance of this extension of our regular work can be fully appreciated only by those who are intimately acquainted with the difficulties and defects of our present system of instruction; but the main aspects of this matter can be readily understood. The educational problem of the institute, as has already been stated, is to give to students with only a high-school preparation a liberal education, a thorough training in fundamental scientific subjects, and sufficient technical knowledge to enable them to enter at once upon the practise of their profession. Under the present conditions, as I have already said, we must for most of our students attempt to do this as far as possible in a period of four years. The opportunities of the four-year period have, however, not yet been fully utilized. Our summer vacations form one third of the whole year; and during this time most of our younger students are unoccupied or are at work in places from which they derive no educational advantage. The assignment of even four or five weeks of the summer vacations after the first and second years to those portions of our work which consist largely in the acquirement of technical skill and experience, such as laboratory practise, shop-work, drawing and work in the field and in industrial establishments, would so relieve the present overcrowded curriculum that an amount of good entirely out of proportion to the time gained could be accomplished. The time gained would, I am sure, be devoted by the faculty not to further specialization in the engineering branches, but to some increase in general studies and to more thorough training in the fundamental principles of the sciences underlying the professional work. The attempt would be made to concentrate the attention of the student upon fewer subjects at one time, to demand more thought and less learning

of lessons, and to emphasize important principles through the solution of numerous problems by the student. The pressure of the studies of the school year would be somewhat diminished; while the work of the summer school, being largely in laboratory, shop or field, and concentrated upon one or two subjects, would not continue the mental strain to any great extent. The plan would involve increased expense to the institute; for it would be necessary to pay the salaries of the instructors engaged in the summer schools for an additional month. Aside from this, the only important objection to it seems to be the added tax that it imposes upon the resources of certain students in forcing them to meet the expenses of living in Boston for a longer period and in shortening the time which they can devote to remunerative work. This makes it, in my opinion, out of the question to charge an additional tuition fee for such required summer courses; but this is not a sufficient argument for postponing a step which is so essential to the effectiveness of our work.

INVESTIGATIONS BY THE INSTRUCTING STAFF

An extension of opportunities for investigation both in pure and in applied science by members of our staff and by advanced students is a matter which, though secondary to the considerations directly affecting the instruction and general welfare of undergraduate students, is nevertheless of the greatest importance in its effect on the relation of the institute to the scientific and technical development of this country. It ought to be our especial aim to get into the closest touch with the scientific problems of the manufacturer and the community, and to assist in the solution of them. Professors and instructors on our staff are already doing a vast amount of work in this direction, partly through the thesis work of students, and partly through

their own employment as experts. But this work is often performed under conditions which make a thoroughgoing investigation impossible; and, because of its personal character, it fails to be identified with the institute and recognized among its contributions to scientific progress. In my opinion, we should in all departments give each of our assistants and instructors a reasonable proportion of free time for research purposes, we should afford him adequate laboratory facilities, and should then insist as a condition of his promotion and advancement in salary that he make and publish scientific or technical investigations. Almost all our instructors already have some available time that could be devoted to research work, so that the carrying out of this suggestion does not involve a proportionate increase in our staff. That time is, however, at present so limited, so disconnected, and so apt to be encroached upon by other work, that the man feels little encouragement to enter upon an investigation. If that amount of time could be increased and made definite by the assignment of days or half-days for research work, there would result not only an incalculable gain to himself as a teacher, investigator and scholar, but also added reputation to the institute because of its larger contributions to science.

ESTABLISHMENT OF RESEARCH LABORATORIES

Another method of promoting investigation work at the institute is through the establishment of research laboratories in connection with the departments. For each such laboratory an income of about \$5,000 needs to be guaranteed for at least a few years. Two laboratories have already been started which are devoted to research in physical chemistry and in sewage disposal, and their contributions to pure science in the one case and to questions of municipal sanitation in the other

have attracted much attention throughout the country. The formal organization of research laboratories accomplishes much more than the same expenditure of money for uncorrelated investigations by the individual members of the departments. It calls attention to the activity of the institute in this field, raises its scientific standing, attracts advanced students, who are often just as effective research workers as inexperienced assistants, offers facilities and inducements for advanced study and investigation to our younger instructors, and forms a nucleus of development in this important direction.

SCIENTIFIC BOOKS

American Philosophy: The Early Schools.

By I. WOODBRIDGE RILEY, Ph.D. New York, Dodd, Mead and Co. 1907. Pp. x + 595.

This substantial volume, the fruit of the author's three years' tenure of the Johnston research scholarship in Johns Hopkins University, constitutes the achievement of the first and most difficult part of an important undertaking, the neglect of which hitherto has been a reproach to American learning. That none have before attempted, on any adequate scale, the task which Dr. Riley is carrying through is perhaps partly due to a common impression that a history of earlier American philosophy would necessarily have the brevity of the chapter on snakes in Iceland. The first of the services rendered by the present publication is that such an impression can not well continue to prevail, in view of the evidence now given of the existence of much vigorous and independent activity in speculation and scientific inquiry even in the eighteenth century. But it has always been reasonably apparent that some sort of intellectual processes must have been continuously at work in American life from the time of the founding of the earliest colleges down to the present. Yet, in spite of a considerable literature of books and monographs on special topics, we have thus far had nothing that was properly entitled to be called an intellectual history of America—

a history based on an extensive collation and first-hand study of the sources, and covering the intellectual movements of all parts of the country. The nearest approach to this hitherto has been the work of a Dominican scholar, written in French. Such a history Dr. Riley, however, has undertaken to provide. It is (what is still a thing sufficiently uncommon amongst us) an *œuvre de longue haleine* that he has proposed to himself; the present volume, which leaves off at the foreshadowings of transcendentalism, is designed to be followed by two others. What distinguishes this part of the work is the novelty of much of the material, and the thoroughness with which the author has documented himself for his task. He even seems to have read through the whole series of Harvard Dudleian lectures on natural religion since 1755—a sort of cruel and unusual punishment which one might almost have supposed contrary to law in these mild days.

The interest of the book is, of course, more historical than philosophical; but it is by no means merely antiquarian. The author has, perhaps, found no American philosopher to whose writings many are likely to resort for the solution of contemporary problems. But he has rescued from oblivion some writers whom it is still possible to read with pleasure, and he has set forth, convincingly for the most part, not merely the vicissitudes of philosophical opinion—especially in academic circles—in America, but also the causes of those vicissitudes. A large part of the book may, indeed, be regarded as a record of the rise and fall of the scientific spirit and of intellectual vitality in the colleges. It is, in the main, a melancholy story of the triumph of obscurantism and mediocrity, of the suppression of ideas and the defeat of tendencies which were destined, after all, to be recalled from their graves and to exercise a powerful influence upon the university teaching of a later generation. Thus, in the first half of the eighteenth century there was an interesting development, in Johnson and Edwards, of philosophical idealism, which, like the doctrine of the Cambridge and Oxford Platonists from which it was, in the main, descended, showed